CV T160: Connected Vehicle Certification Testing Introduction

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1. Module Description

The CV T160 module follows related modules I261/CV-261: V2I (Vehicle-to-Infrastructure) Standards for Project Managers and I262/CV262: V2V (Vehicle-to-Vehicle) ITS Standards for Project Managers. V2I refers to Vehicle to Infrastructure applications, such as broadcasting the traffic signal phase and timing countdowns as well as lane placement to approaching vehicles for red light violation warning. V2V refers to Vehicle to Vehicle applications, such as broadcasting vehicle location, heading, speed, and elevation to one another for crash avoidance. While I261 and I262 describe the standards required for vehicle and roadside equipment interoperability throughout North America, CV T160 focuses upon Certification Testing to the conformance of the connected vehicle hardware and software to the published standards.

2. Introduction/Purpose

The connected vehicle environment has the potential to transform surface transportation systems such that vehicular crashes are significantly reduced, operators of the surface transportation systems have access to more accurate system performance data, and travelers have access to specific traveler information, and allow the surface transportation systems to be optimized to minimize environmental impacts.

This module begins with an introduction to the certification testing process of Roadside Unit (RSU) and On-Board Unit (OBU) devices to ensure that communications between vehicles and roadside equipment is private, secure, and interoperable throughout North America. It is essential that agencies use standards certification tests in deploying connected vehicle technologies to maximize the benefits from the connected vehicle environment. By taking this module, participants will learn how to specify certification requirements in contract terms and conditions. Deploying certified Connected Vehicle equipment will support interoperability, minimize future integration costs, make procurements easier, and facilitate regional and national integration

This module continues to cover the privacy and security measures taken in the connected vehicle architecture to insure authenticity of the data exchanges and to insure that no personal identification information is included in the data transmitted.

3. Samples/Examples

3.1. Why is certification important?

For the first time, vehicle active safety systems must rely on data received from other vehicles and the roadside equipment, instead of only data from the vehicle itself. Traditional Traffic Management and Control are shown in the shaded area of Figure 1:

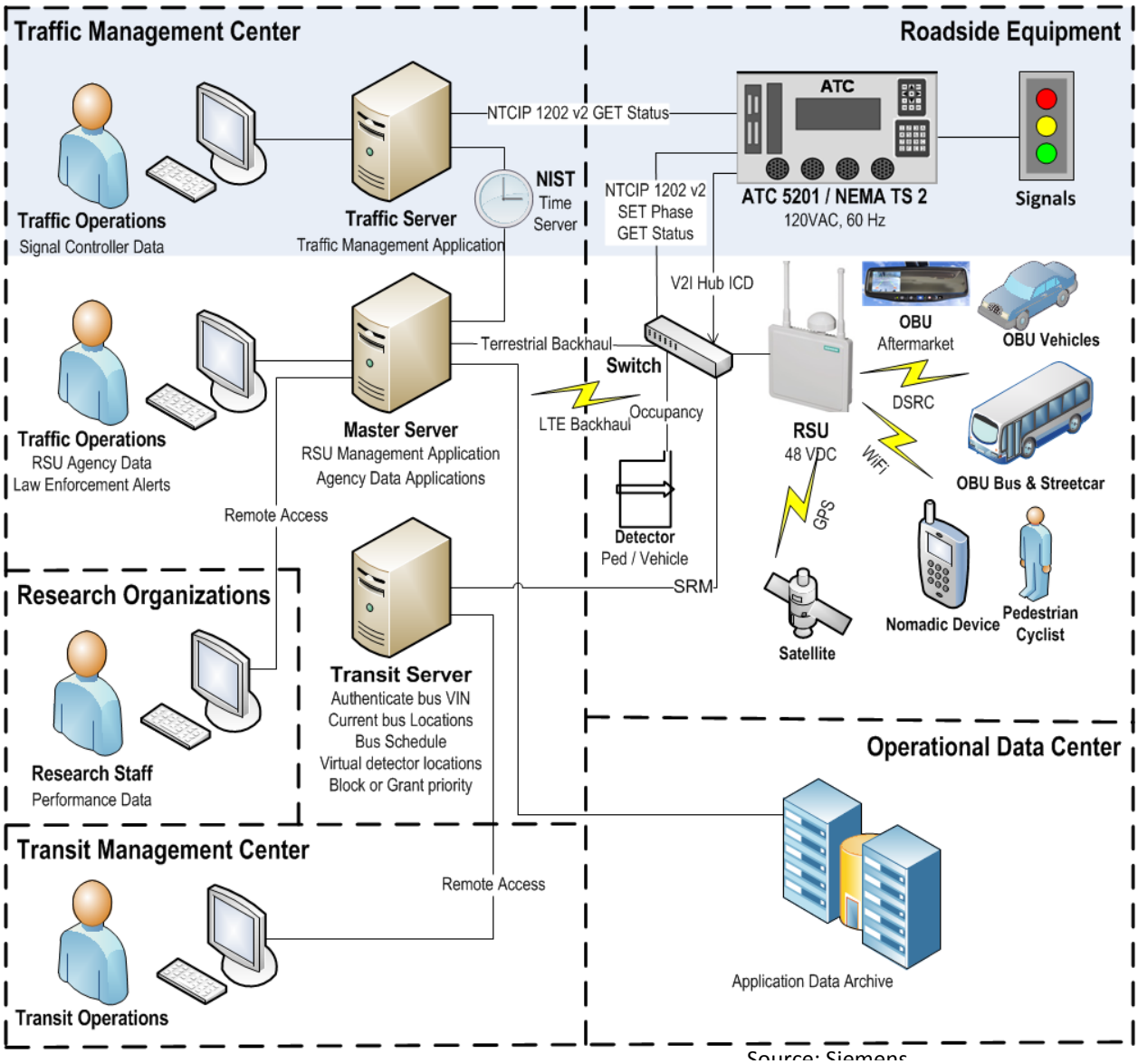


Figure 1: Importance of Certification, Interdependent Data Flows

3.2. Test and Certification Levels

Testing and certification occurs at Levels as shown in Figure 2:

Level 1: Procurement of software objects and hardware objects

Level 2: Test of software modules and hardware units

Level 3: Integration test of software modules installed into hardware objects to form subsystems

Level 4: Acceptance test of system to fulfill Use Case requirements

Level 5: Validation of system installed in roadside equipment and vehicles

Level 6: End to end system test, operation and maintenance

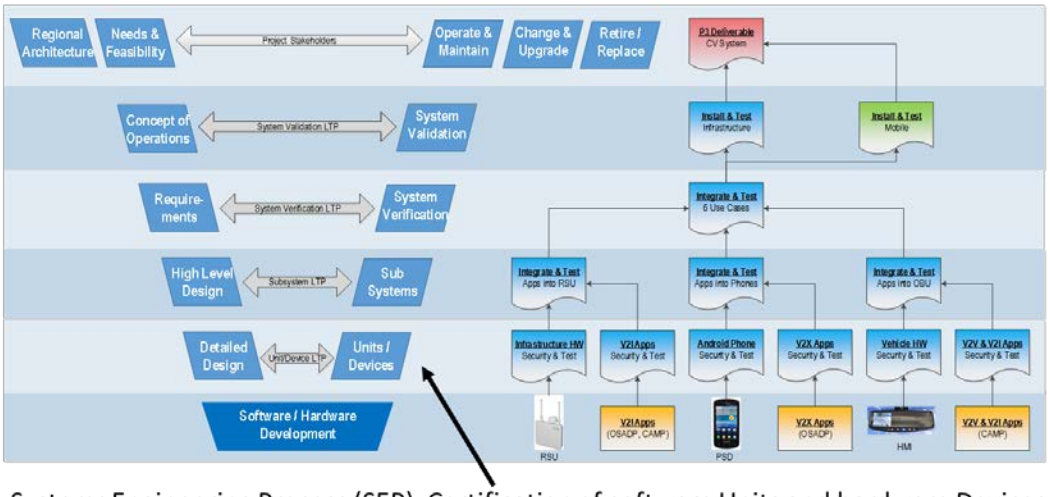


Figure 2: Test and Certification Levels

4. Reference to Other Standards

Connected Vehicle Wireless Stack standards compliance certifications are shown in Figure 3.

IEEE 1609.2		
	IPv6	IPv6
	1609.3, 802.2, 802.11p	IEEE 802.2
	5.9 GHz wireless (802.11p), 1609.4	Backhaul PHY[2]

Source:

Figure 3: Wireless Stack Standards

5. Case Study: USDOT Connected Vehicle Pilots

USDOT funded three Connected Vehicle Pilots in which we will preview the THEA case study:

1. Rural: Wyoming DOT Interstate 80 heavy truck corridor
2. Suburban: Tampa Hillsborough Expressway Authority (THEA)
3. Urban: New York City DOT

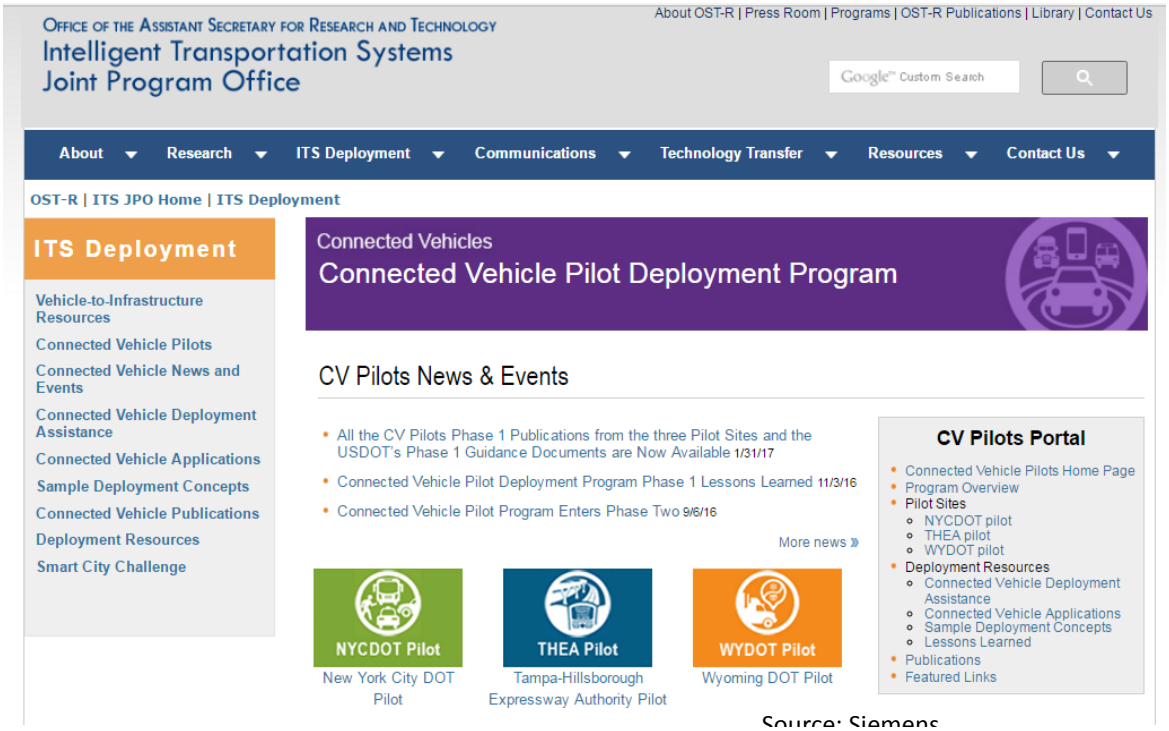


Figure 4: USDOT Connected Vehicle Pilots

The THEA Suburban CV pilot focuses on a "before and after" study of the effectiveness of 11 CV applications deployed as six use cases at six locations in downtown Tampa FL, with existing safety and mobility issues as shown in Figure 5.

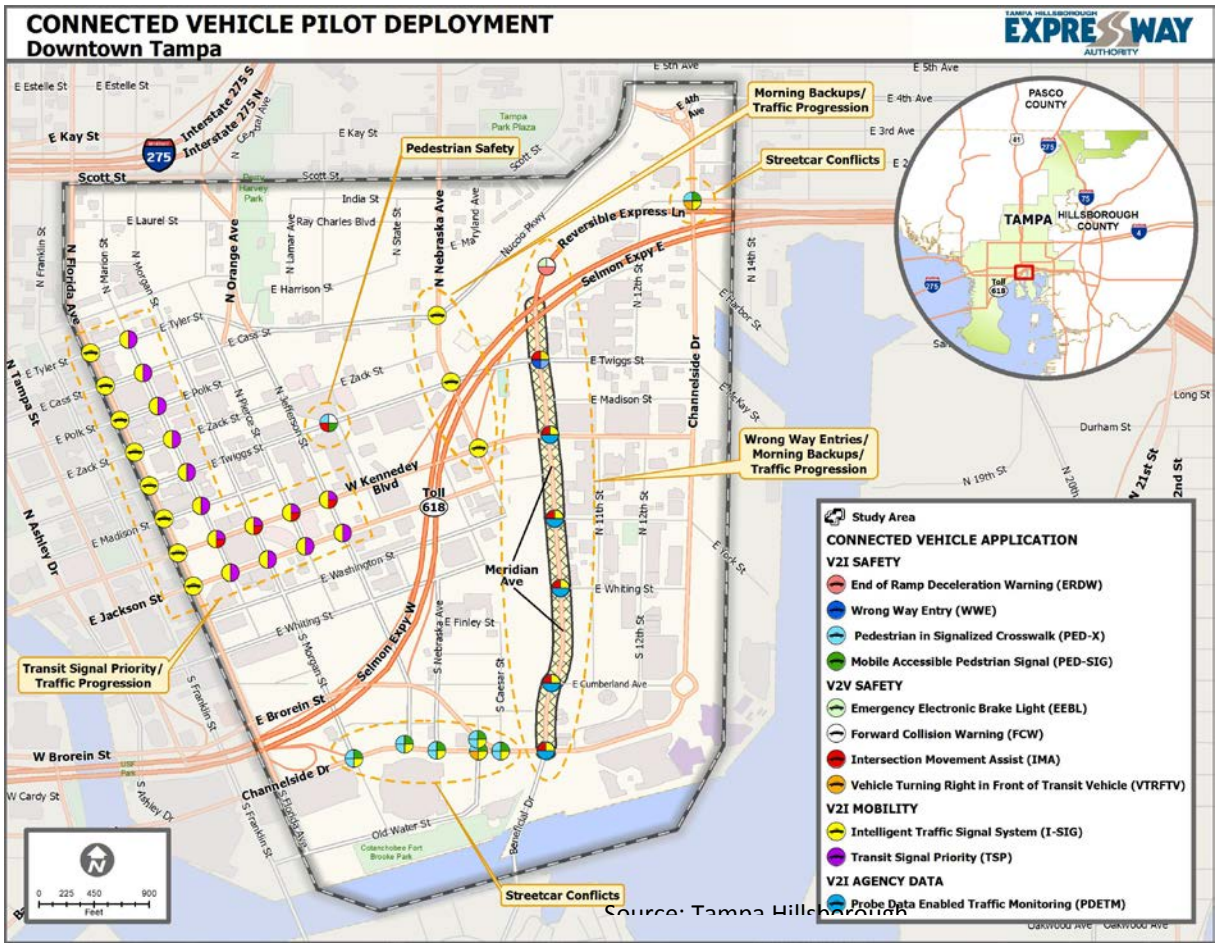


Figure 5: THEA CV Pilot Study Area and Deployments

Each of the V2I and V2V applications shown in Figure 6 are selected from the list of CV applications on the USDOT website shown in Figure 7.

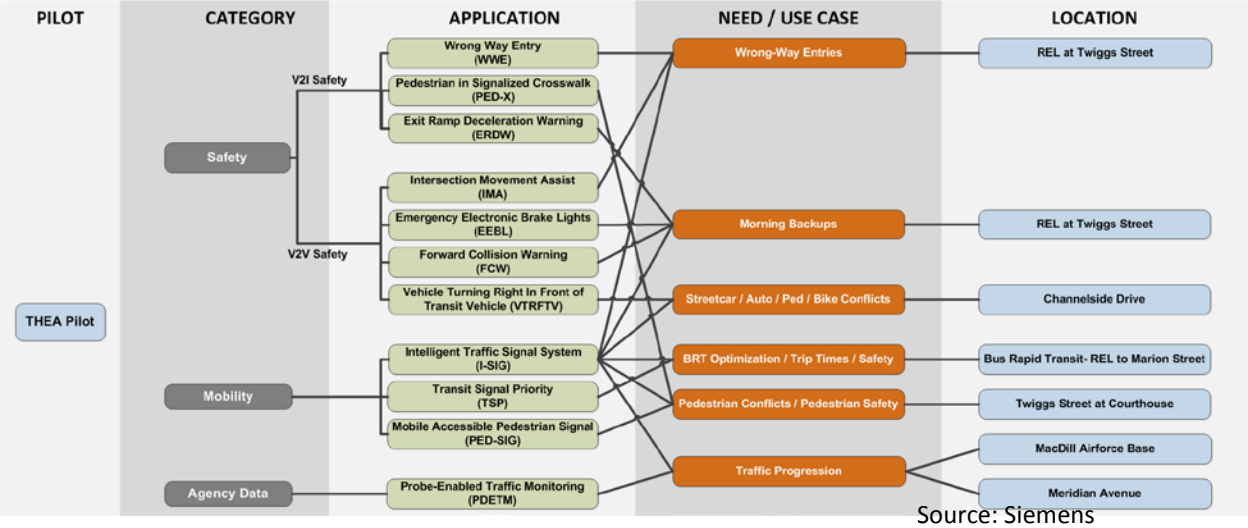


Figure 6: Eleven CV Applications Deployed as Six Use Cases

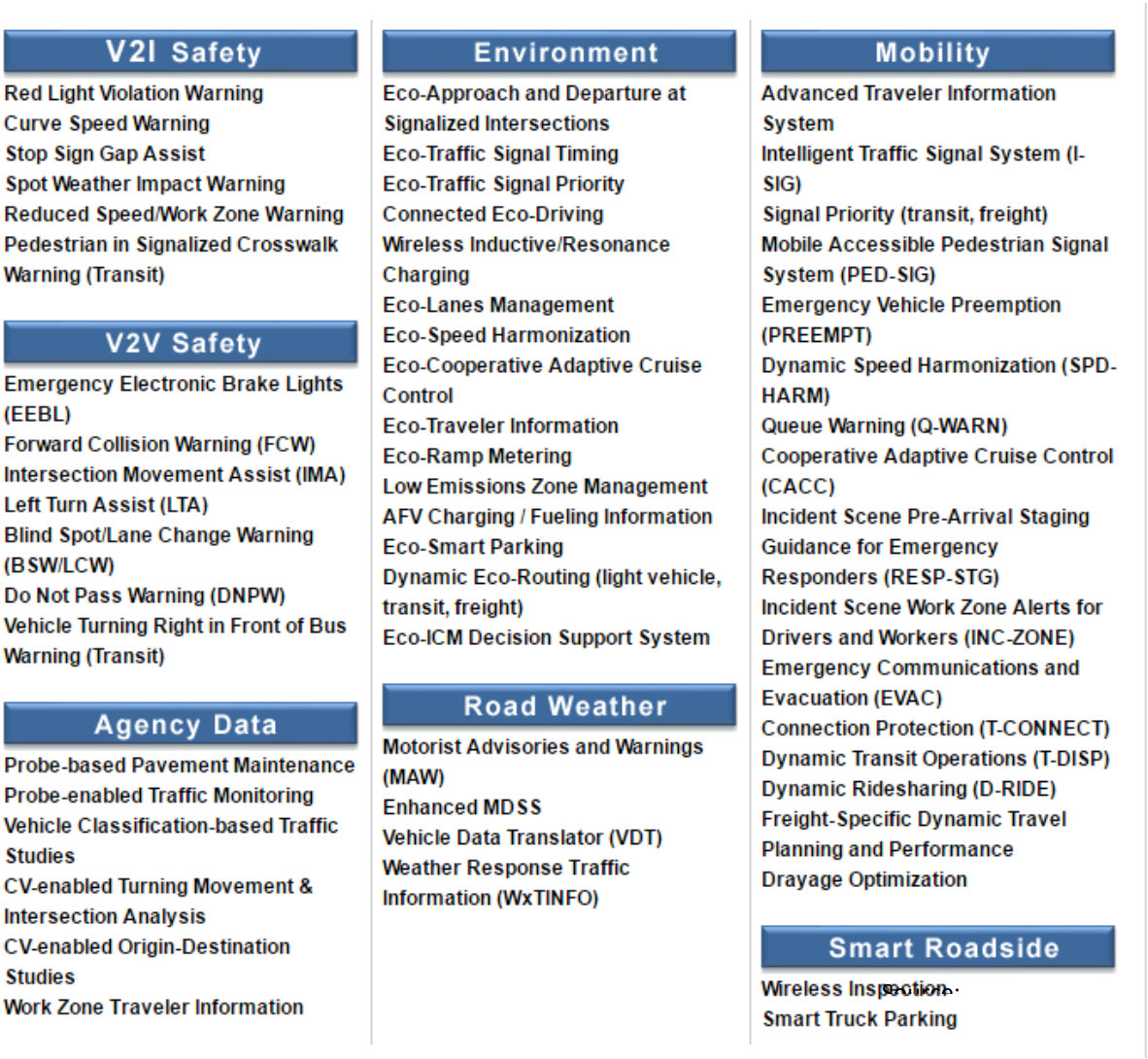


Figure 7: Connected Vehicle Applications

Figure 8 depicts Use Case 1: Morning Backups. Here, I-SIG and Curve Speed Warning CV applications are used to reduce ramp exit speed to within the stopping distances of the Florida Drivers Manual as the morning queue builds and reduces the safe stopping distance.

Source: Siemens

Figure 8: Use Case 1, Morning Backups using End of Lane Deceleration Warning application

Figure 9 depicts use of Wrong Way Warning when a vehicle attempts to enter the closed or inbound lanes of the Reversible Elevated Expressway (REL). The CV apps warn the violating driver before the violation occurs, warns the oncoming vehicle of a wrong-way driver, and alerts law enforcement as the violation persists.

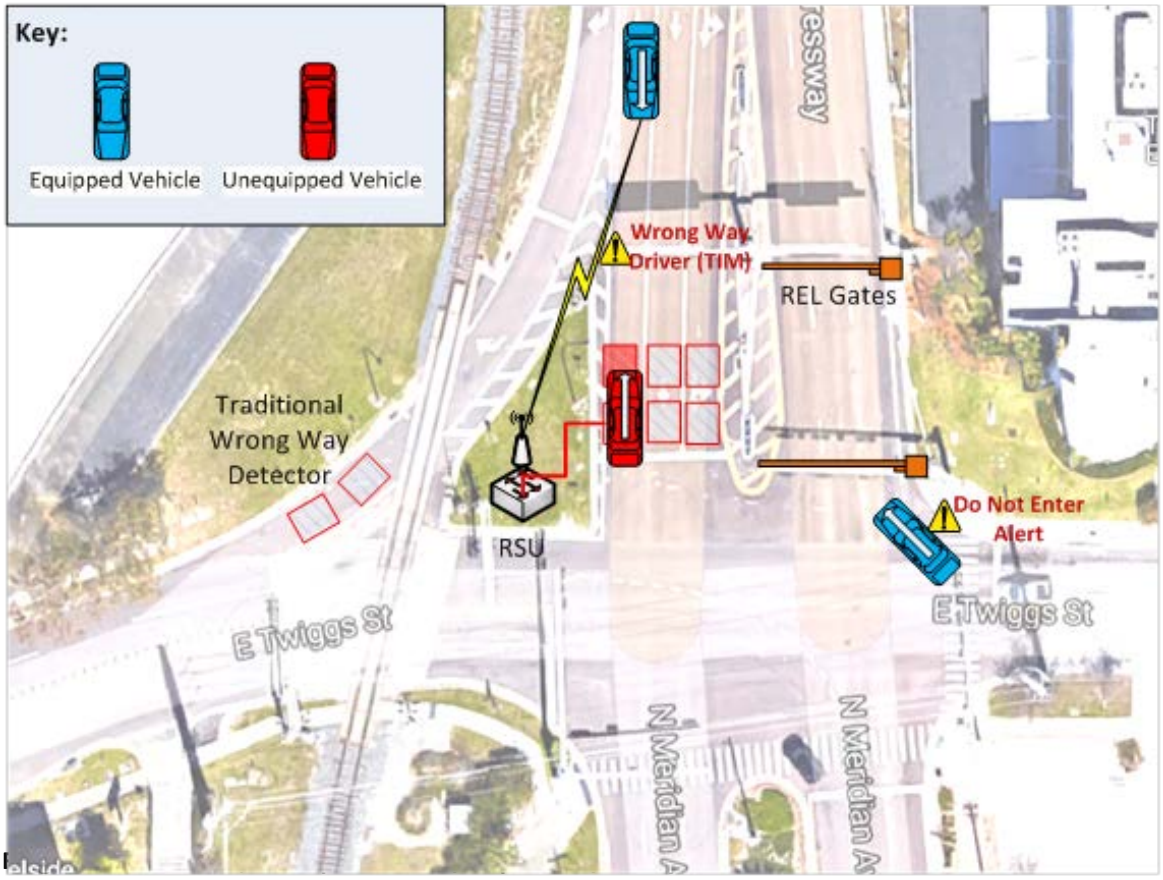
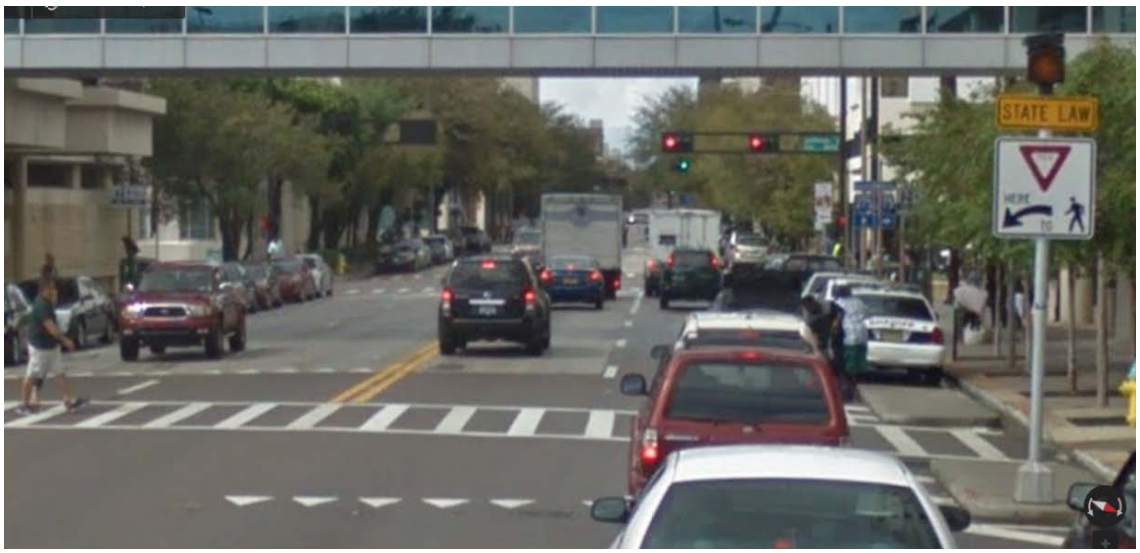


Figure 10: Use Case 2, Wrong Way Entries

Figure 10 depicts use of Forward Collision Warning and Intersection Movement Assist for pedestrian safety in an uncontrolled midblock crosswalk.



Source: HNTB

Figure 11: Use Case 3, Pedestrian Conflicts / Pedestrian Safety

Figure 11 depicts use of Connected Vehicle Transit Signal Priority (TSP) using standard CV messages compatible with the new car messages to be able to use platoons of automated and connected vehicles as transit priority.

Source: HNTB

Figure 12: Use Case 4, BRT Optimization / Trip Times / Safety

Figure 12 depicts use of Connected Vehicle I-SIG application to control signals based on the arrival times and priorities of vehicles instead of timing plans.

Source: HNTB

Figure 13: Use Case 5, Traffic Progression

Figure 13 depicts the aggregation of Basic Safety Messages into Vehicle Classification, speeds, and volumes without need for special roadside equipment.

Source: Siemens

The RSU also aggregates **Basic Safety Messages (BSM)** and sends those to the CMS.

Aggregated BSMs have the **same function as conventional loop detectors** and provide traffic data:

- Type of vehicle
- Speed
- Traffic volume in vehicles/hour

Figure 14: Use Case 6, Agency Data

6. Glossary

To include additional **descriptions/acronyms** used primarily in the module.

Term	Definition
Agency Specification	A document that has been prepared by an agency to define requirements for a subject item or process when procured by the agency.
BSM	Basic Safety Message
Compliance	A condition that exists when an item meets all of the requirements of an agency specification.
Concept of Operations	A document that describes the purpose for a system project, including a description of the current and proposed system, as well as key user needs that the new system is required to address.
Conformance	A condition that exists when an item meets all of the mandatory requirements as defined by a standard. It can be measured on the standard as a whole, which means that it meets all mandatory (and applicable conditional) requirements of the standard, or on a feature level (i.e., it conforms to feature X as defined in section X.X.X), which means that it meets all mandatory (and applicable conditional) requirements of the feature.

7. References

Connected Vehicle Pilot Deployment Program Phase 1, Concept of Operations (ConOps) – Tampa (THEA), Final Report — February, 2016 FHWA-JPO-16-311

USDOT Connected Vehicle Pilot Development Program: http://www.its.dot.gov/pilots/

USDOT Connected Vehicle Applications: http://www.its.dot.gov/pilots/cv_pilot_apps.htm

USDOT Certification Project:
http://www.its.dot.gov/presentations/plugfest_2016/Certification_Overview.pdf

Connected Vehicle Pilot Deployment Program Overview:
http://www.its.dot.gov/pilots/pdf/CV_PilotWebinar5_Devices_QPL.pdf

Certification program for 5.9GHz DSRC:
http://omniair.org/wp-content/uploads/2016/10/2016ITSWC-TP66-7layers_Dmitri-Khijniak-notes-1.pdf

USDOT Guidance for Security Operational Concept:
https://ntl.bts.gov/lib/60000/60400/60495/FHWA-JPO-16-338.pdf

Security Credential Management System Proof of Concept:
http://www.its.dot.gov/pilots/pdf/SCMS_POC_EE_Requirements20160111_1655.pdf

USDOT Plug Fest (Secure Credential Management System (SCMS) Proof of Concept (PoC) Overview)
http://www.its.dot.gov/presentations/plugfest_2016/SCMS_Plugfest.pdf

ITS Standards Training Modules: MODULE 38. I262/CV-262 Vehicle-to-Vehicle (V2V) ITS Standards for Project Managers
https://www.pcb.its.dot.gov/StandardsTraining/Modules.aspx?ModuleID=67#mod67

DSRC Roadside Unit Specifications:
http://www.fdot.gov/traffic/Doc_Library/PDF/USDOT%20RSU%20Specification%204%201_Final_R1.pdf

8. Study Questions

To include the quiz/poll questions and answer choices as presented in the PowerPoint slide to allow students to either follow along with the recording or refer to the quiz at a later date in the supplement.

1. What is the relationship between the RSE and RSU?
    a) RSE is the DSRC radio to the nearby vehicles
    b) RSU includes the RSE
    c) RSU is the DSRC radio that is part of the RSE
    d) Backhaul connects the RSE with the RSU

2. Which is not part of the RSU wireless stack?
    a) IPV6 device addresses
    b) Basic Safety Message (BSM) of vehicle location, heading speed, elevation
    c) 5.9 GHz wireless frequency band
    d) IEEE 1609.2 security certificates

3. Which of the following applies to Agencies requiring RSU certification process?
    a) Develop RSU Test Cases per each agency
    b) Specify independent certification test report per Certification Test Specification, with special provisions for local needs
    c) Purchase RSUs without contract requirements
    d) None of the above

4. Which of the following is not a CV application group?
    a) V2V Safety
    b) V2I Mobility
    c) Road and Weather
    d) Autopilot for self-driving vehicle

9. Icon Guide

The following icons are used throughout the module to visually indicate the corresponding learning concept listed out below, and/or to highlight a specific point in the training material.

1) **Background information:** General knowledge that is available elsewhere and is outside the module being presented. This will be used primarily in the beginning of slide set when reviewing information readers are expected to already know.

2) **Tools/Applications:** An industry-specific item a person would use to accomplish a specific task, and applying that tool to fit your need.

3) **Remember:** Used when referencing something already discussed in the module that is necessary to recount.

4) **Refer to Student Supplement:** Items or information that are further explained/detailed in the Student Supplement.

5) **Example:** Can be real-world (case study), hypothetical, a sample of a table, etc.

6) **Checklist:** Use to indicate a process that is being laid out sequentially.